CNTT-E-147

BASIC ELECTRICTY AND ELECTRONICS

STUDENT HANDOUT

NO. 310

SUMMARIES PROGRESS CHECKS AND JOB PROGRAMS FOR MODULES

32-3 & 32-4

JUNE 1984

SUMMARY
LESSON 3

Wien-Bridge Oscillator

In your previous study of oscillators you learned how the Hartley oscillator and the RC Phase shift oscillator accomplished 360° of phase shift. Remember that this phase shift is necessary in order to provide regenerative feedback to initiate and sustain oscillation.

The Wien-bridge oscillator also requires 360° of phase shifting. With the Wien-bridge oscillator, the phase shift is provided by two amplifiers. Each amplifier accomplishes 180° of phase shift.

The bridge portion of the oscillator determines the output frequency and maintains a constant output amplitude. Figure 1 shows the schematic of the bridge circuit together with block diagrams for the two amplifiers which make up the remainder of the Wien bridge circuit.

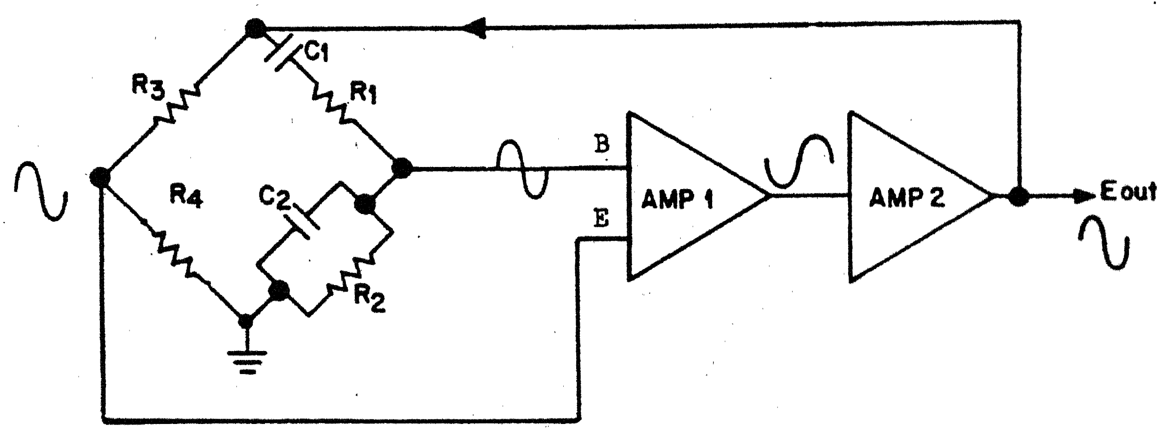


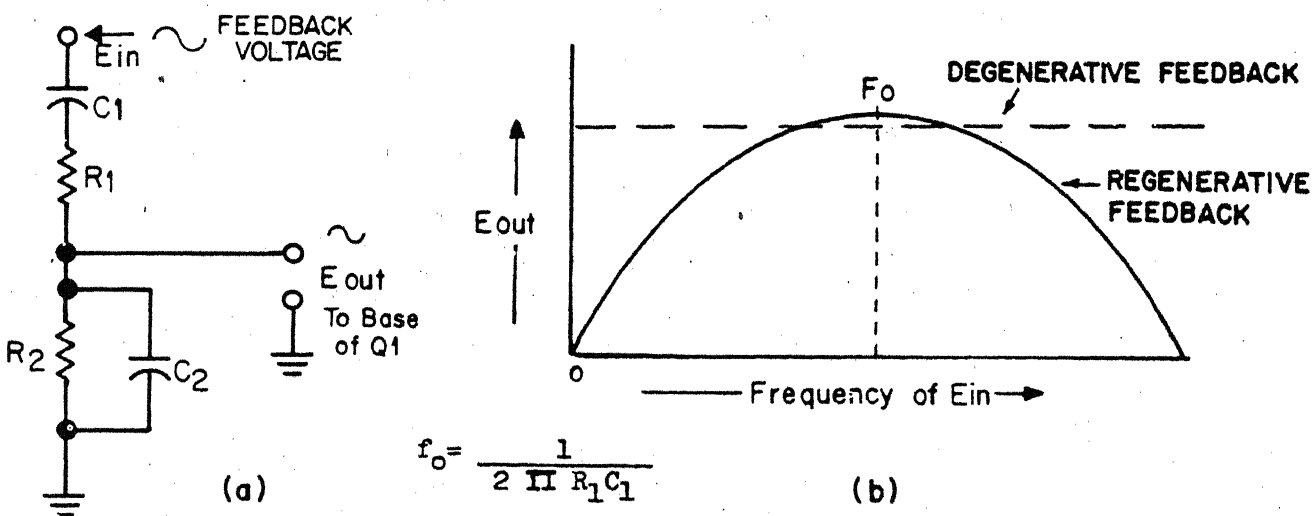
Figure 1

WIEN-BRIDGE OSCILLATOR BLOCK DIAGRAM

Frequency selection in the Wien-bridge oscillator is the result of the resistive-reactive bridge circuit comprised of capacitors C_1 and C_2 and R_1 and R_2. The output of this circuitry is a single frequency, with zero degree phase shift and maximum amplitude. All other frequencies are effectively eliminated. The regenerative output from the bridge circuit is applied to the base of the transistor in the first stage of amplification.

The remaining components of the bridge circuit, namely, R_3 and R_4 form a voltage divider which provides a degenerative voltage. The output of this circuit is applied to the emitter of the transistor in the first amplifier. Because this voltage is applied to the emitter it opposes the regenerative voltage applied to the transistor's base. Circuit oscillation occurs only when the regenerative feedback voltage exceeds the degenerative feedback voltage. The degenerative feedback voltage acts to regulate the amplitude of the output voltage and improves the purity of the output waveform. Changes in the amplitude of the output signal are automatically compensated for by the degenerative portion of the bridge ciruit. This is necessary to maintain the output amplitude at a constant level.

Figure 2 shows the schematic for the frequency determining network of the Wien-bridge oscillator together with a drawing which shows the relationship of the output voltage amplitude to the frequency of oscillator operation.



$$f_o = \frac{1}{2\pi R_1 C_1}$$

Figure 2

FREQUENCY DETERMINING NETWORK

The frequency of the oscillator is determined by the formula $1 \div 2\pi$ where R_1= R_2 and C_1=C_2. In this example, and in many Wien-bridge oscillators, R_1 and R_2 are equal value resistors and C_1 and C_2 are equal value capacitors. The output frequency of the oscillator may be changed by increasing or decreasing the resistance or capacitance of R or C in the frequency determining portion of the bridge. At frequencies below the oscillator frequency, the output amplitude of the RC network is less than the output amplitude at the frequency of operation. This is due to the high reactance of C1. At one frequency the reactance of C_1 and C_2 compensate

for each other. This leaves only the resistance of R_1 and R_2. At this frequency, the circuit is purely resistive, no phase shift occurs, with the result that the output voltage is at maximum and is greater than the degenerative voltage.

Refer to the right hand side of Figure 2 and notice that when the output frequency is at the oscillator frequency, the regenerative voltage is greater than the degenerative voltage. Notice also that the degenerative voltage is shown by the dotted line. When the circuit operates at Fo, a maximum regenerative feedback voltage is provided. Because this feedback is greater than the degenerative feedback, oscillation occurs and is sustained. At frequencies above the oscillator frequency (Fo), the reactance values are reduced and C_2 becomes the controlling reactance. Recall that in a parallel circuit, the smaller resistance or reactance controls the circuit. Therefore, since the reactance of C_2 controls the parallel combination of R_2-C_2, this causes the output voltage to be less than that at the frequency of operation.

The drawing shown in Figure 3 shows a redrawn version of the Wien bridge circuit together with block diagrams for the two amplifiers which are part of the total circuit.

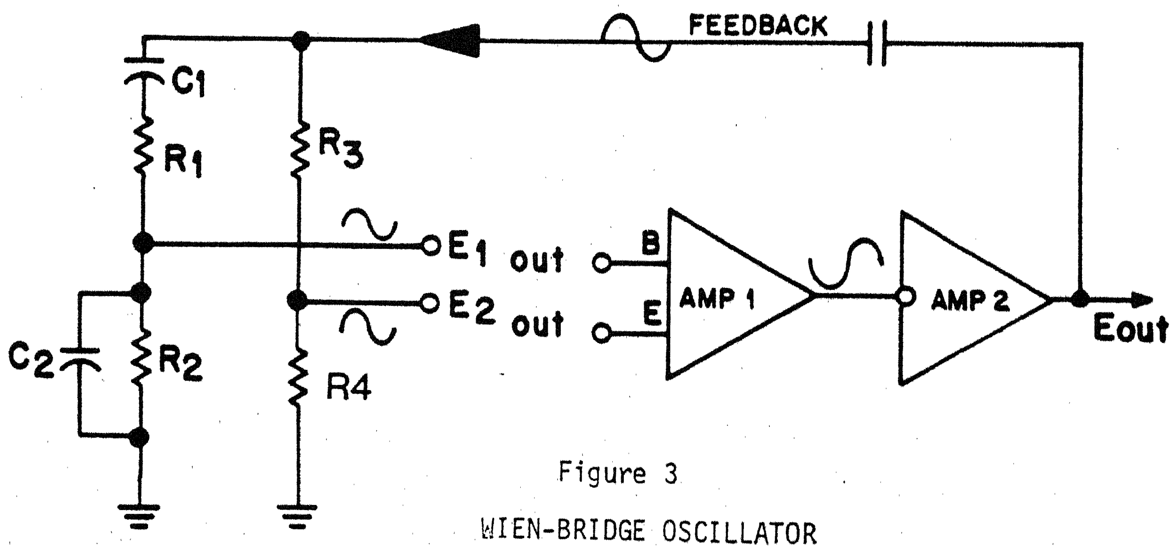


Figure 3

WIEN-BRIDGE OSCILLATOR

The two outputs of the bridge circuit are identified as E_1 out and E_2 out. E_1 is the output from the frequency determining section of the bridge circuit and this regenerative output is applied to the base of the first amplifier. E_2 is the output from the voltage divider, is degenerative, and applied to the emitter of the first amplifier stage.

The schematic shown in Figure 4 is that of a complete Wien bridge circuit.

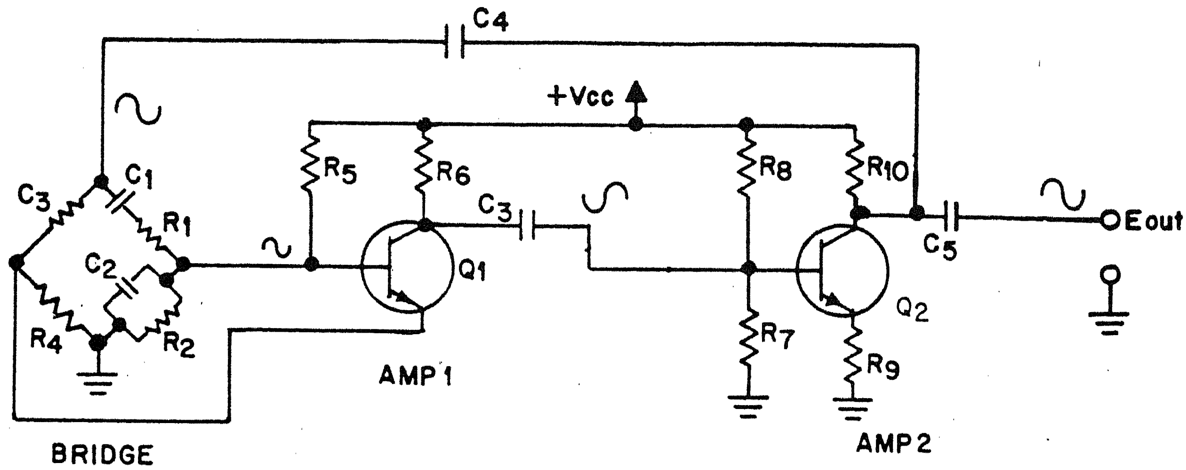


Figure 4

WIEN-BRIDGE OSCILLATOR

In addition to the bridge circuit, the two amplifier circuits which accomplish the 360° phase shift are shown. Notice that waveforms are also indicated on the schematic. Both of the amplifiers in this circuit are biased to operate in Class A service. Recall that this class of operation causes the transistor to conduct during the entire input cycle and produces a distortion-free output. Notice particularly that the regenerative feedback is connected to the base of Q_1 and the degenerative feedback is connected to the emitter of the transistor. Recall also that the degenerative feedback opposes the regenerative feedback applied to the transistor's base.

The function of the amplifier stage components is as follows: Forward bias for transistor Q_1 is provided by voltage divider R2/R5, while R7/R8 perform the same function for Q_2. R6 and R10 act as collector load resistors while R4 and R9 are emitter resistors for Q_1 and Q_2 respectively. C3 functions as the inter-stage coupling capacitor and C5 is the output coupling capacitor. C4 is the feedback capacitor which couples a portion of the output signal back to the bridge circuit.

In the Wien-bridge oscillator circuit automatic gain control (AGC) is used in order to maintain the output amplitude stability. This is shown in Figure 5.

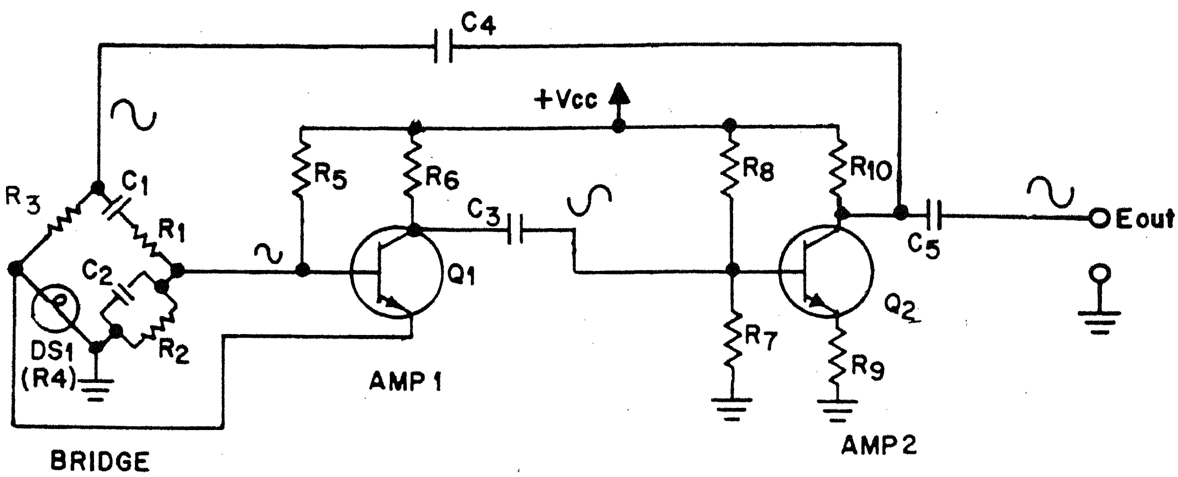


Figure 5

WIEN-BRIDGE OSCILLATOR CIRCUIT WITH AGC

The control is accomplished by substituting a tungsten filament lamp for R_4 in the degenerative voltage divider circuit part of the bridge. This is shown in the schematic. The lamp is designated as DS1. The resistance of the lamp varies as the temperature of its filament increases or decreases. Any increase in the resistance of R_4 (DS1) results in a higher degenerative feedback voltage, whereas any decrease in the resistance results in a smaller degenerative voltage. The tungsten lamp operates much like an AC voltage regulator and maintains a constant output amplitude by varying the amount of degenerative voltage applied to the emitter of transistor Q_1. A thermistor may be used instead of the lamp. This device is also temperature sensitive and functions like the lamp. Thermistors are available with either positive or negative temperature coefficients. The circuit application will determine the type of thermistor which is required. With the Wien-bridge oscillator, a thermistor with a positive temperature coefficient is required.

Since the output frequency of the Wien-bridge oscillator may be changed by changing the values of C_1 and C_2, it is possible to have a variable frequency Wien-bridge oscillator. The schematic for such an oscillator is shown in Figure 6.

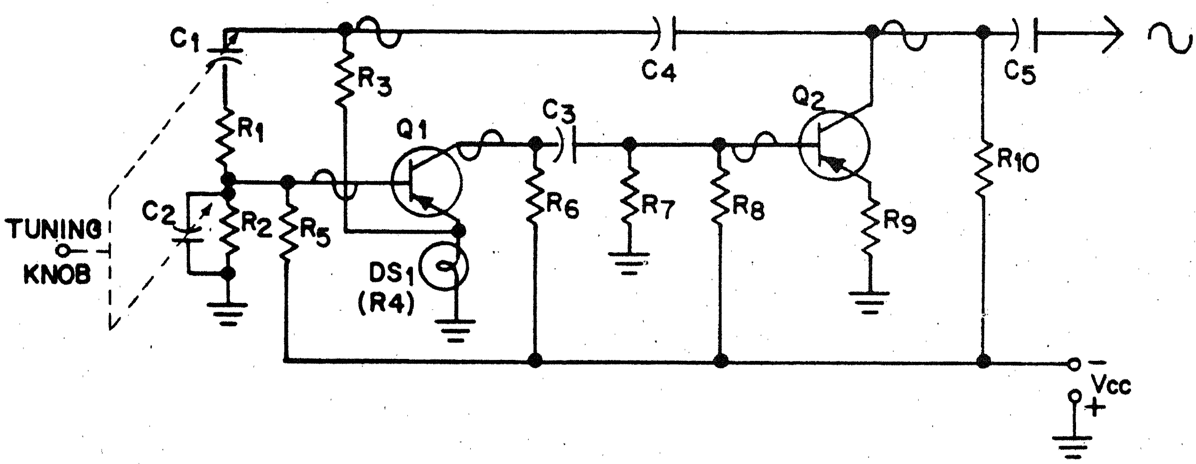


Figure 6

VARIABLE FREQUENCY WIEN-BRIDGE OSCILLATOR

Notice that the circuit shown in Figure 6 is similar to the circuit shown in Figure 5 except C_1 and C_2 are ganged and variable which allows the output frequency of the oscillator to be varied. When variable capacitors are used in the Wien bridge circuit the frequency may be varied from several Hz to over 200 kHz. Again refer to the schematic shown in Figure 7 and notice that PNP transistors may be used. Notice also the waveforms which have been superimposed on the schematic to help you understand the operation of the Wien-bridge oscillator circuit.

AT THIS POINT, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, YOU MAY TAKE THE LESSON TEST. IF YOU INCORRECTLY ANSWER ONLY A FEW OF THE PROGRESS CHECK QUESTIONS, THE CORRECT ANSWER PAGE WILL REFER YOU TO THE APPROPRIATE PAGES, PARAGRAPHS, OR FRAMES SO THAT YOU CAN RESTUDY THE PARTS OF THIS LESSON YOU ARE HAVING DIFFICULTY WITH. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

PROGRESS CHECK
LESSON THREE

Wien-Bridge Oscillator

1. Wien-bridge oscillator circuits are used most frequently with:

   a. test and laboratory equipment.
   b. power and amplifier equipment.
   c. voltage multipliers and transmission equipment.
   d. RC networks and tank circuits.

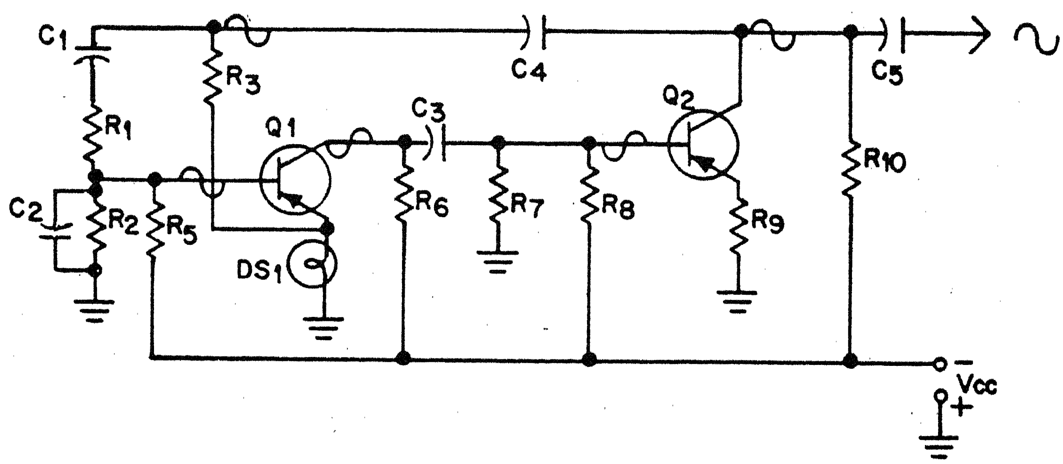
2. The Wien-bridge oscillator has the advantage of:

   a. variable frequency with a stable sawtooth output waveform.
   b. constant amplitude with a variable sawtooth output waveform.
   c. variable pulse output waveform with a constant amplitude.
   d. constant amplitude output with excellent frequency stability.

3. The 360° phase shift of a Wien-bridge oscillator is the result of ______________________ action.

   a. RC network
   b. tank circuit
   c. amplifier
   d. rectifier

REFER TO THE SCHEMATIC SHOWN BELOW WHEN ANSWERING QUESTIONS 4 AND 5.



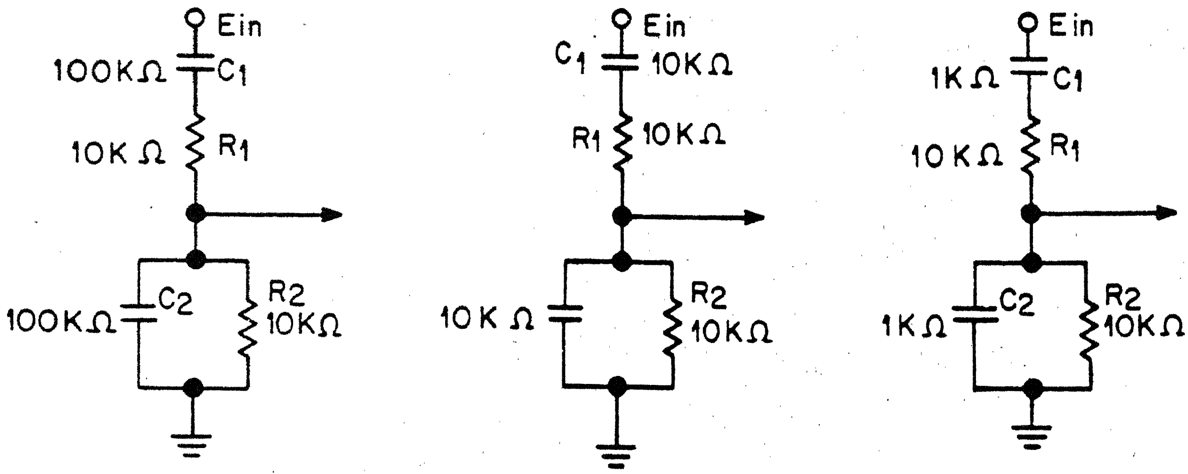
4. The frequency of the oscillator is determined by a(n)

   a. transformer.
   b. LC tank.
   c. resistive-capacitive bridge.
   d. inductive-capacitive bridge.

5. The output frequency of the oscillator may be increased by ____________ the resistance of ______________.

   a. increasing, R3 and R4
   b. decreasing, R3 and R4
   c. increasing, R1 and R2
   d. decreasing, R1 and R2

REFER TO THE SCHEMATICS BELOW WHEN ANSWERING QUESTION 6.

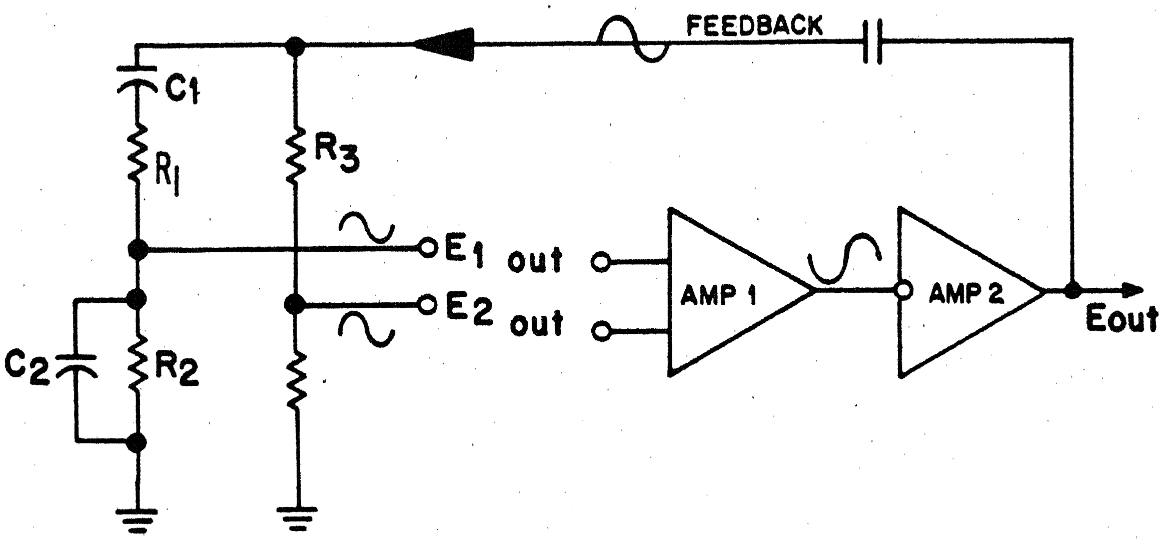


(1) (2) (3)

6. The circuit which provides the maximum AC output voltage is

a. 1
b. 2
c. 3

REFER TO THE DRAWING SHOWN BELOW WHEN ANSWERING QUESTIONS 7 AND 8.



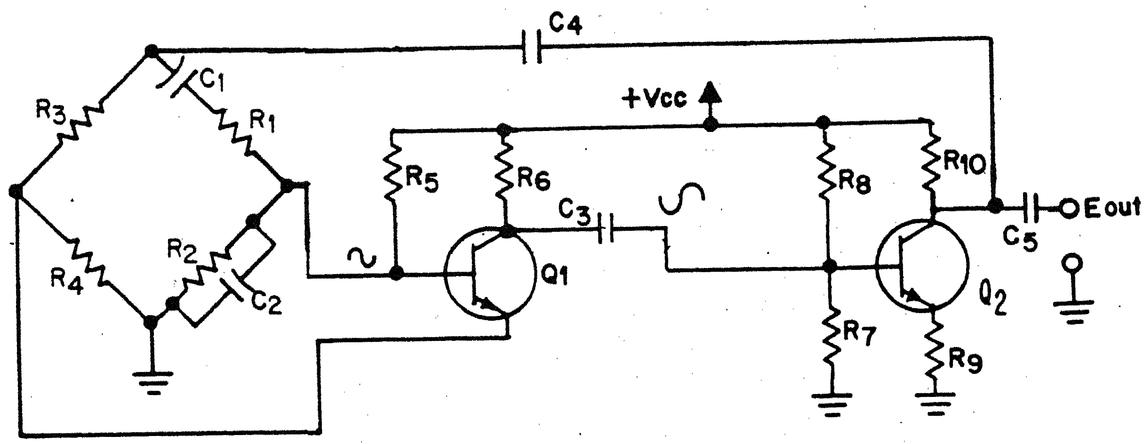
7. The output at E1 is ______________________ and is applied to the ___________________ of the first amplifier stage.

   a. degenerative, emitter
   b. regenerative, emitter
   c. degenerative, base
   d. regenerative, base

8. The output at E2 is _______________ and is applied to the _____________________ of the first amplifier stage.

   a. regenerative, emitter
   b. degenerative, emitter
   c. regenerative, base
   d. degenerative, base

REFER TO THE OSCILLATOR SCHEMATIC SHOWN BELOW WHEN ANSWERING QUESTIONS 9 AND 10.



9. The output frequency of the oscillator is determined by

   a. R1, R2, C1, and C2.
   b. R3, R4, R6, and Q1.
   c. R3 and R4.
   d. Q1, Q2, and R10.

10. Automatic gain control (AGC) may be provided by substituting a thermistor or tungsten filament lamp for:

    a. Q1
    b. R5
    c. R4
    d. R3

CHECK YOUR RESPONSES TO THIS PROGRESS CHECK WITH THE ANSWER SHEET. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE LESSON TEST. IF YOU INCORRECTLY ANSWER ONLY A FEW OF THE PROGRESS CHECK QUESTIONS, THE CORRECT ANSWER PAGE WILL REFER YOU TO THE APPROPRIATE PAGES, PARAGRAPHS, OR FRAMES SO THAT YOU CAN RESTUDY THE PARTS OF THIS LESSON YOU ARE HAVING DIFFICULTY WITH. IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

SUMMARY
LESSON 4

Blocking Oscillator

When you studied oscillators previously, you learned about oscillators that provide sine-wave outputs. The blocking oscillator is a special type of oscillator that produces a short duration, pulse output waveform. The pulse output waveform of the blocking oscillator is used in radar equipment, computers, and other equipment where timing is required. The blocking oscillator generates a very narrow output pulse.

There are a number of terms that you should become familiar with prior to proceeding with the lesson on blocking oscillators. These terms, listed below, are also used with radar equipment.

PULSE WIDTH (PW) Pulse width is the time from the start of the pulse to the end of the pulse.

PULSE REPETITION TIME (PRT) Pulse repetition time is the time from the start of one pulse to the start of the next pulse. It is measured from the leading edge of one pulse to the leading edge of the next pulse.

PULSE REPETITION FREQUENCY (PRF) Pulse repetition frequency refers to the frequency at which pulses occur. The frequency is usually stated in cycles per second.

PULSE REPETITION RATE (PRR) Pulse repetition rate is the number of pulses per second (PPS).

The blocking oscillator uses a special type of transformer. This transformer is constructed in such a way that it passes a square wave or pulse with a minimum amount of distortion. The transformer is called a pulse transformer. The schematic diagram for the pulse transformer is shown in Figure 1.

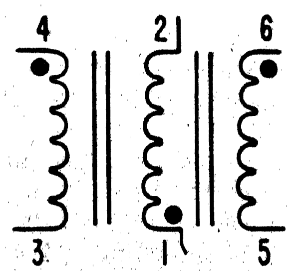


Figure 1

PULSE TRANSFORMER SCHEMATIC SYMBOL

The pulse transformer differs from other transformers in that it has two secondary windings. The second secondary winding is called a tertiatry winding. Tertiary means third. The three windings of the pulse transformer are wound on the same iron core in such a way that voltages are induced into both the secondary and tertiary windings simultaneously. Refer to the figure and notice that phasing dots are shown. Therefore, the voltage polarity of pins 1, 4, and 6 is identical. The pulse transformer is designed and constructed in a special way so it saturates at a low current level. Once the transformer is saturated, any futher increase in current through the primary has no effect on the secondary output voltage. This is necessary if the blocking oscillator is to function properly.

The schematic diagram shown in Figure 2 is that of a blocking oscillator.

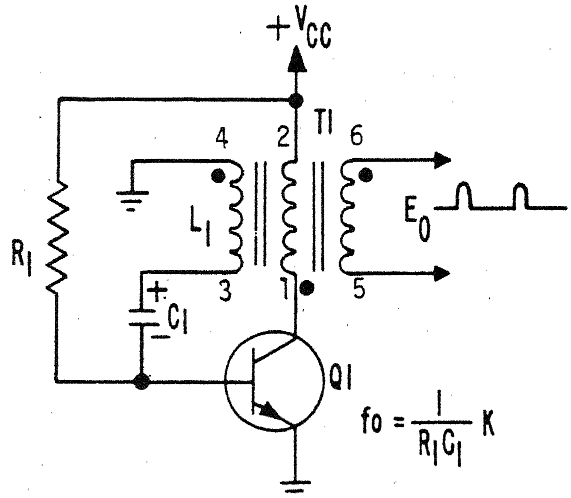


Figure 2

BASIC BLOCKING OSCILLATOR CIRCUIT

In may ways, this circuit is similar to the Armstrong oscillator circuit. The major difference between the two oscillator circuits is in the frequency determining circuitry. Whereas the frequency of the Armstrong oscillator is determined by a tank circuit, the blocking oscillator output frequency depends on the RC network made up of R1 and C1. In both cases, regenerative feedback is necessary in order to intiate and sustain oscillation. With the blocking oscillator, regenerative feedback is provided by the inductive coupling of the transformer's primary and secondary. Forward bias is provided by R1, which is connected between Vcc and the base of transistor Q1, to provide initial conduction of Q1.

Refer again to the schematic shown in Figure 2. Because of the positive potential resulting from the action or R1, transistor Q1 is forward biased. As a result of this bias, when power is applied the transistor conducts. Since the resistance between the emitter and collector of Q1 is reduced, current now flows from ground through Q1, the primary of the transformer T1, and to Vcc. This results in a negative polarity at pin 1 and a positive polarity at pin 3 due to the transformer action. The positive signal from pin 3 is applied to the base of Q1 and increases the transistor's forward bias and the transistor conducts more. This action continues until the transistor or the pulse transformer reach the point of saturation. Since the pulse transformer is designed to saturate quite readily, the transformer reaches the point of saturation before the transistor.

At the same time current flows through Q1, capacitor C1 charges to a voltage equal to the secondary voltage of the pulse transformer. When the capacitor is fully charged, the current between the base and emitter of Q1 is reduced to a point where the transistor can no longer conduct. In effect, the transistor is cut off at this time. In other words, when the charge on capacitor C1 reaches maximum, the transistor cuts off.

The capacitor charge at this time is equal to the peak secondary voltage of the transformer's secondary (pin 3-4). At this time, since transistor conduction has stopped, the primary magnetic field of the transformer collapses. Remember from your study of inductors that an inductor opposes a change in current and therefore, in this case, the inductance will attempt to keep current flowing in the same direction. When the magnetic field of the transformer primary collapses, the voltage across capacitor C1 and transformer secondary (3 and 4) series aid each other and exceed the voltage at Vcc. Because the secondary voltage of the transformer is series aided by C1's voltage, the potential applied to the base of Q1 is now negative. At this time the transistor becomes reverse biased.

Q1 remains cut off, or blocked by this reverse bias until capacitor C1 discharges to a point where the voltage at Vcc exceeds C1's potential. Because a transistor is blocked for a significant amount of time during each cycle of operation, the circuit is called a blocking oscillator circuit. The time required for the capacitor to discharge is determined by the time constant resulting from the interaction of R1 and C1. If you have difficulty understanding how an RC network functions refer to Module 11. Eventually the capacitor discharges to a point where the positive Vcc voltage is again applied to the base of Q1. When this happens the transistor is again forward biased, it conducts and the transformer action produces regenerative feedback. The cycle repeats and repeats producing a pulsed type output.

The output waveform of the circuit across terminals 5 and 6 of the transformer is shown in Figure 3.

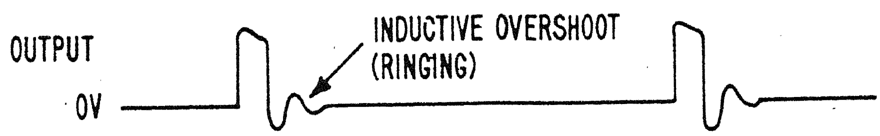


Figure 3

BLOCKING OSCILLATOR OUTPUT-TERTIARY WINDING

Examine the waveform and notice the inductive overshoot or ringing effect. This is an undesirable output resulting from the rapid current changes through the transformer windings. Because these damped oscillations may cause problems in other circuits associated with the blocking oscillator, it is necessary to eliminate this inductive overshoot or ringing.

One technique that is commonly used to eliminate the inductive overshoot or ringing, is to use clamping diodes as shown in Figure 4.

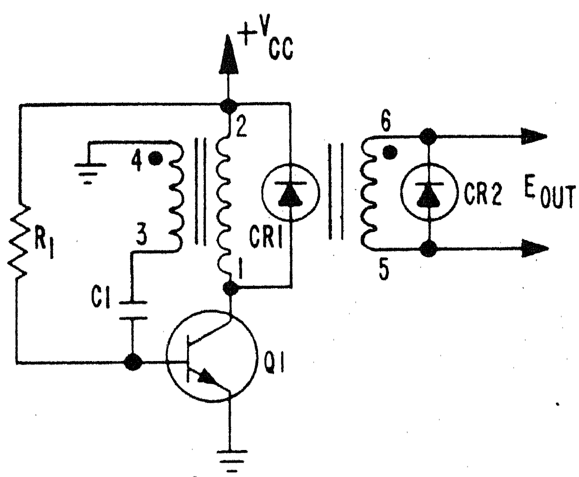


Figure 4

BLOCKING OSCILLATOR WITH CLAMPING DIODES

In this example, a clamping diode CR1 is placed directly across terminals 1 and 2 of the transformer's primary. When Q1 cuts off, the voltage across terminals 1 and 2 of the transformer reverses polarity, causing diode CR1 to become forward biased. Because diode CR1 has a low resistance when forward biased, the inductive overshoot voltage and the ringing is quickly damped out.

Another method often used for reducing the ringing is to connect a diode across the output winding of the pulse transformer. This is also shown in Figure 4. This diode, diode CR2, becomes forward biased whenever the output voltage at terminal 6 is negative in relation to terminal 5. Because of the diode action, the output is limited, or clamped, to within a few tenths of a volt. This results in an output waveform that is relatively free of inductive overshoot or ringing.

Another means of reducing the ringing action of the transformer is to use resistive loads commonly called dampers. In this case, small value resistors are placed in series or shunt with the transformer secondary or tertiary windings. Resistors used in this way absorb some of the oscillations caused by the rapid collapse of the transformer's magnetic field. It is also possible to use both resistors and clamping diodes. Circuit design characteristics determine whether clamping diodes and resistive loads are used together or independently.

The schematic diagram shown in Figure 5 is a slight variation of the basic blocking oscillator circuit. This is the schematic for the NIDA blocking oscillator which you will use and become familiar with when you complete the job program associated with this lesson.

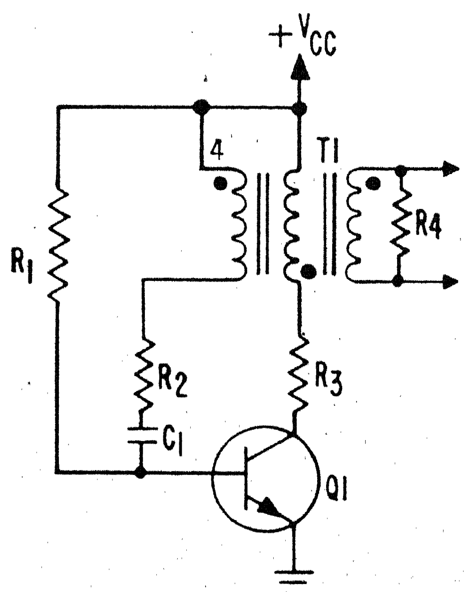


Figure 5

NIDA BLOCKING OSCILLATOR SCHEMATIC

The basic difference between this circuit and the blocking oscillator circuit which you previously studied is that terminal 4 of transformer T1 is returned to Vcc vice ground. An arrangement of this type removes the Vcc power source from the discharge path of the capacitor and improves the total stability of the circuit. Other than this difference, the operation of the NIDA blocking oscillator is essentially the same as a basic blocking oscillato circuit. In this case, notice that resistors R2, R3 and R4 function to dampen part of the undesirable oscillation of the transformer resulting from rapid current variation.

There are several variations of the basic circuit; for example, triggered, synchronized, divided (count-down) versions of the oscillator circuit. The basic distinction between these circuits and the basic circuit is that the variations require input triggers.

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PROGRESS CHECK
LESSON 1

Blocking Oscillators

1. Which of the oscillators listed below would produce a waveform other than a sine wave?

   a. Phase Shift
   b. Wienbridge
   c. LC
   d. Blocking

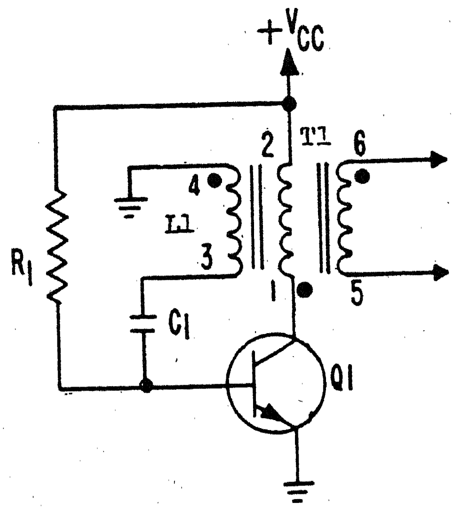
2. A certain blocking oscillator has a pulse repetition frequency of 625 pps. What is the PRT?

   a. 1.6 msec
   b. 16 msec
   c. 160 msec
   d. 1600 msec

3. Which of the terms listed below is the equivalent of pulse repetition frequency (PRF)?

   a. PW
   b. PRT
   c. PRR
   d. PRS

REFER TO FIGURE 1 TO ANSWER QUESTIONS 4, 5, AND 6.



4. During the time a pulse is being generated

   a. C1 is discharging.
   b. C1 is charging.
   c. Ic is decreasing.
   d. Eo is zero.

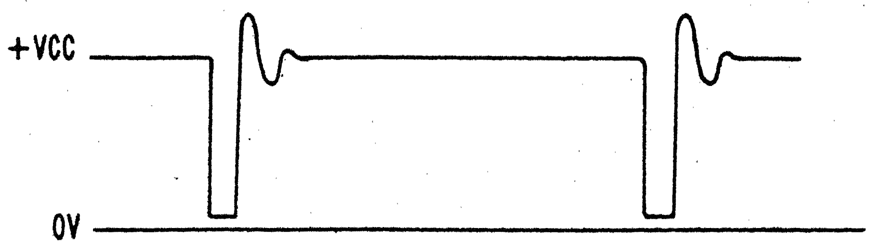
5. The pulse repetition frequency (PRF) of a blocking oscillator is determined primarily by the

   a. RC time of R1 and C1.
   b. primary winding of T1.
   c. RC time of R1, and L1.
   d. secondary winding of T1.

6. Regenerative feedback is accomplished by

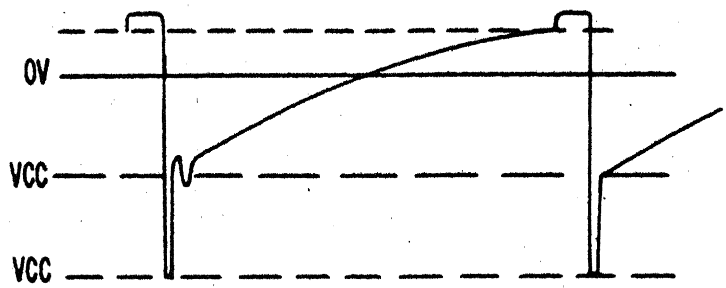
   a. R1 and C1.
   b. the tertiary winding.
   c. the collapsing field of the primary winding.
   d. inductive coupling primary to secondary.

7. Refer to the diagram shown. The waveform represents the



a. output waveform.
b. collapse of the primary winding.
c. discharge of C1.
d. collector waveform.

8. Refer to the figure shown. The waveform shown represents the waveform



a. across the tertiary winding.
b. at the collector of Q1.
c. across the secondary winding.
d. at the base of Q1.

9. Ringing in a blocking oscillator may be eliminated by using

a. a swamping resistor across the tertiary winding.
b. a diode across the primary winding.
c. a diode across the tertiary winding.
d. all of the above.

10. The primary cause of ringing in a blocking oscillator is the

a. collapse of the primary magnetic field.
b. expanding of the primary magnetic field.
c. discharge of C1 through Q1.
d. inductive coupling primary to secondary.

CHECK YOUR RESPONSES TO THIS PROGRESS CHECK WITH THE ANSWER SHEET. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE JOB PROGRAM. IF YOU INCORRECTLY ANSWER ONLY A FEW OF THE PROGRESS CHECK QUESTIONS, THE CORRECT ANSWER PAGE WILL REFER YOU TO THE APPROPRIATE PAGES, PARAGRAPHS, OR FRAMES SO THAT YOU CAN RESTUDY THE PARTS OF THIS LESSON YOU ARE HAVING DIFFICULTY WITH. IF YOU FEEL YOU HAVE FAILED TO INDERSTAND ALL, OR MOST, OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

JOB PROGRAM FOR LESSON IV

Blocking Oscillator

INTRODUCTION

This Job Program is designed to permit you to analyze the operation of the free running blocking oscillator. It will reinforce your knowledge of the free running blocking oscillator you studied in the narrative, programmed instruction or summary.

SAFETY PRECAUTIONS:

Observe all standard safety precautions. Beware of all open and exposed connections; an energized circuit may have dangerous voltages present.

EQUIPMENT AND MATERIALS

1. NIDA 203 Audio Oscillator
2. PC 203-6 Printed Circuit Board
3. Oscilloscope
4. AN/USM-207 Frequency Counter
5. 10X Probe (1)
6. BNC Tee Connector (1)
7. BNC-BNC Cable (2)
8. Double Alligator Clip Shorting Wire (1)
9. Blocking Oscillator Schematic Diagram

<u>PROCEDURES:</u> DO NOT USE A DMM FOR MEASURING PN JUNCTION RESISTANCE. NORMALLY A DMM DOES NOT HAVE SUFFICIENT VOLTAGE TO FORWARD BIAS A TRANSISTOR JUNCTION.

1. Set up and energize the oscillscope for single trace operation using the channel #2 display mode with an EXTERNAL TRIGGER input. (Allow sufficient time for the oscilloscope to warm up).

2. Set up and energize the AN/USM-207 frequency counter to measure period. (Refer to job program Thirty Two-2, if necessary, in order to do this).

3. Connect the tee connector to the external trigger source jack of the oscilloscope. Connect one BNC cable between the NIDA 203 front panel jack and the tee connector. Connect the other BNC cable between the tee connector and the channel #1 input of the oscilloscope.

4. Remove the top cover from the NIDA 203 audio oscillator and install the PC-203 PCB.

5. Plug in and energize the NIDA 203 audio oscillator.

6. Turn the amplitude control on the front panel of the audio oscillator fully CW.

7. Connect the 10X probe to the channel #2 input to the oscilloscope.

8. Place the other end of the 10X probe between Pin #8 and ground of the NIDA 203 audio oscillator.

   a. Calculate the Pulse Repetition Rate (PRR) of the waveform shown on the scope____________.

   b. Calculate the width of the pulse (PW)____________.

   c. Calculate the rest time from the scope presentation____________.

9. On the AN/USM-207 frequency counter, set the channel "A" sensitivity control to the "FREQ C" position. Change the power switch from "STBY" to the "STORE" position.

10. Set the time base switch (black knob) to 10^3 and the function switch to 10^2.

11. Disconnect the BNC-BNC cable running from the audio oscillator to the tee connector at the tee connector, and connect it to the channel "B" input of the AN/USM-207.

NOTE: Remember from a previous job program that the trigger volts controls are very sensitive and must be adjusted carefully to obtain a correct reading, and that channel "B" is used for period measurements and channel "C" for frequency measurements.

12. Set the channel "B" black knob at "3" and turn the red knob to midrange.

   a. What is the reading on the counter? ______________.

   b. Does this reading approximate the sum of your calculations in steps 8b plus 8c above (+ or - .2 msec)? ________________ yes/no.

13. Remove the BNC connector from channel "B" and connect it to channel "C" of the AN/USM-207.

14. Set the function switch to the FREQ position and the time base switch (black knob) to position 1.

15. Set the trigger volts control black knob at position 3 and turn the red knob fully CW.

   a. What frequency is being indicated by the counter? __________.

   b. Does this indication approximate the frequency you calculated from the scope in step 8(a) above? ____________ yes/no.

16. Disconnect the BNC connector from the channel "C" connection of the AN/USM-207 and connect it to the tee connector of the oscilloscope.

17. Place the AN/USM-207 frequency counter in standby.

18. Set the oscilloscope for dual trace operation by pushing in the "ALT" switch of the display mode switches.

19. Connect the 10X probe to the base of Q1. The waveform at the base of Q1 is a result of the charging and discharging of C1. By observing the output and the waveform at the base of Q1 simultaneously, the relationship between the charging and discharing of C1 and the output can be seen.

NOTE: Notice the small sinusoidal pulse at the end of the main pulse. This pulse is known as "ringing" and is undesirable in practical blocking oscillators. The summary, narrative and programmed instruction discuss several methods of eliminating this "ringing", only one which will be shown here. Just to the left of the pulse transformer there is a small diode connected between the junction of C2 and R3 with the cathode connected to a pin which is <u>not</u> connected to any other components.

20. Deenergize the NIDA 203 audio oscillator.

21. Connect one alligator clip of a shorting wire to this pin and the other alligator clip to Pin #6. Notice that you have placed the diode directly across the primary winding of the pulse transformer.

22. Energize the NIDA 203 audio oscillator.

    a. What has happened to the "ringing" pulse? ______________ .
       Increased/decreased/remained the same.

    b. What has happened to the Pulse Repetition Frequency? ______________
       Increased/decreased/remained the same.

NOTE: Do not concern yourself with the change in frequency since a practical blocking oscillator will be designed to take this into consideration.

You have now completed the Job Program for blocking oscillators. You have analyzed the Pulse Repetition Frequency and the Pulse Repetition Time. You have also seen one method that is commonly used to eliminate ringing in an oscillator.

CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON KNOWLEDGE TEST. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL OR MOST OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS, OR CONSULT WITH THE LEARNING CENTER INSTRUCTOR, UNTIL YOUR RESPONSES DO AGREE.

FAULT ANALYSIS

(PAPER TROUBLESHOOTING)

FOR

MODULE 32, LESSON 4

NOW THAT YOU HAVE COMPLETED THE KNOWLEDGE SECTION OF THIS LESSON, YOU ARE READY FOR PAPER TROUBLESHOOTING.

THE COMPUTER WILL ASSIGN YOU A SET OF PAPER TROUBLESHOOTING PROBLEMS ON BLOCKING OSCILLATORS. THESE PROBLEMS WILL HELP YOU DEVELOP THE MENTAL SKILLS REQUIRED IN ACTUAL TROUBLESHOOTING. YOU WILL BE GIVEN SYMPTOMS OF A FAILURE AND CIRCUIT MEASUREMENTS THAT WILL ALLOW YOU TO IDENTIFY THE PROBLEM.

AFTER YOU COMPLETE THE PAPER TROUBLESHOOTING SECTION, THE COMPUTER WILL ASSIGN YOU A PRACTICE TROUBLESHOOTING PROBLEM ON A FAULTY PRINTED CIRCUIT BOARD.

REMEMBER THAT REFERENCE VOLTAGES, WAVEFORMS, AND A SCHEMATIC ARE CONTAINED IN THIS STUDENT GUIDE FOR YOUR USE IN BOTH PAPER AND ACTUAL TROUBLESHOOTING PROBLEMS.

INFORMATION SHEETS

FOR

TROUBLESHOOTING PERFORMANCE TEST

INTRODUCTION:

Using the following six step troubleshooting procedure will aid you in determining which component is faulty. In the split method of troubleshooting, the base of Q1 has been selected as the starting point for this performance test. Based on your interpretation of the scope presentation at this point, you can determine which direction you should go.

EQUIPMENTS:

1. NIDA 203 Audio Oscillator
2. PC203-6 Printed Circuit Board
3. Oscilloscope
4. Simpson 260 Multimeter
5. 10X probe (1)
6. BNC Tee Connector (1)
7. BNC-BNC Cable (2)
8. Blocking Oscillator Schematic Diagram

INSTRUCTIONS:

1. Each student is required to determine the defective component in a prefaulted Blocking Oscillator circuit. Your six step troubleshooting sheet must indicate that you used accurate test measurements and a logical procedure to find the faulty component.

2. Standard test equipment will be available to you in the form of an oscilloscope, and a Simpson 260 multimeter. You will be expected to observe all safety precautions throughout the test. A safety violation will result in an automatic failure of the performance test. In that event you will be counselled and given remedial training.

3. You will take a numbered position in the test room. After a briefing by the Learning Center Instructor you will fill out the heading of the troubleshooting form. On a signal from the Learning Center Instructor you will then start the test. If at any time during the test you should require assistance, raise your hand. DO NOT LEAVE YOUR POSITION. A Learning Center Instructor will assist you with your trouble. If the trouble is due to no fault of your own, you will not be penalized and a time extension will be given if necessary. You will set up the equipment according to the specifications given in the troubleshooting performance test information sheet in this booklet.

TROUBLESHOOTING PERFORMANCE TEST

4. You must identify the faulty component to pass this performance test.

5. If you do not understand these instructions raise your hand and ask your Learning Center Instructor. If you do understand these instructions and upon a signal from your Learning Center Instructor you may now begin the Performance Test on the next page.

TROUBLESHOOTING PERFORMANCE TEST

DIRECTIONS: DO NOT WRITE IN THE PERFORMANCE TEST BOOKLET. MAKE ALL YOUR RESPONSES ON THE SIX STEP TROUBLESHOOTING SHEET SUPPLIED WITH THE TEST PACKET. THIS PERFORMANCE TEST BOOKLET IS DESIGNED TO AID YOU IN COMPLETING THE STANDARD SIX STEP TROUBLESHOOTING FORM. COMPLETE THE STEPS USING YOUR KNOWLEDGE AND SKILL OF THE CIRCUITS SHOWN. CONTACT YOUR LEARNING CENTER INSTRUCTOR IF YOU HAVE ANY QUESTIONS.

SET UP THE EQUIPMENT THE SAME AS YOU DID IN THE JOB PROGRAM. ALL VOLTAGES AND RESISTANCES WILL BE MEASURED WITH REFERENCE TO GROUND UNLESS THE PCB IS REMOVED TO MEASURE FRONT TO BACK RESISTANCE RATIOS OR TO MEASURE THE RESISTANCE OF A SPECIFIC RESISTOR. ALL VOLTAGES AND RESISTANCES MEASURED SHOULD BE WITHIN + OR - 20% TOLERANCEWITH THOSE GIVEN IN THE VOLTAGE RESISTANCE CHART AT THE END OF THIS PERFORMANCE TEST.

STEP ONE - SYMPTOM RECOGNITION

1. Does the equipment energize? _________ Yes/No.

STEP TWO - SYMPTOM ELABORATION

2. No symptom elaboration. Proceed to step 3. No front panel meters.

STEP THREE - LIST THE PROBABLE FAULTY FUNCTION(S)

1. There is only one circuit so there is only one faulty function.

STEP FOUR - LOCALIZE THE FAULTY FUNCTION

1. There is only one circuit so there is only one faulty function.

TROUBLESHOOTING PERFORMANCE TEST

STEP FIVE - LOCALIZE THE FAULTY CIRCUIT/COMPONENT

1. List the test points where actual voltages were taken.
2. What circuit/component in the faulty function listed in step four is faulty?
3. If you have determined the faulty circuit but not the faulty component proceed to part four.
4. Secure the power and using a Simpson 260 take resistance checks.
   a. Continuity checks on printed circuit board foil.
   b. Capacitors can be shorted or open.
   c. Resistors can be open.

STEP SIX - FAILURE ANALYSIS

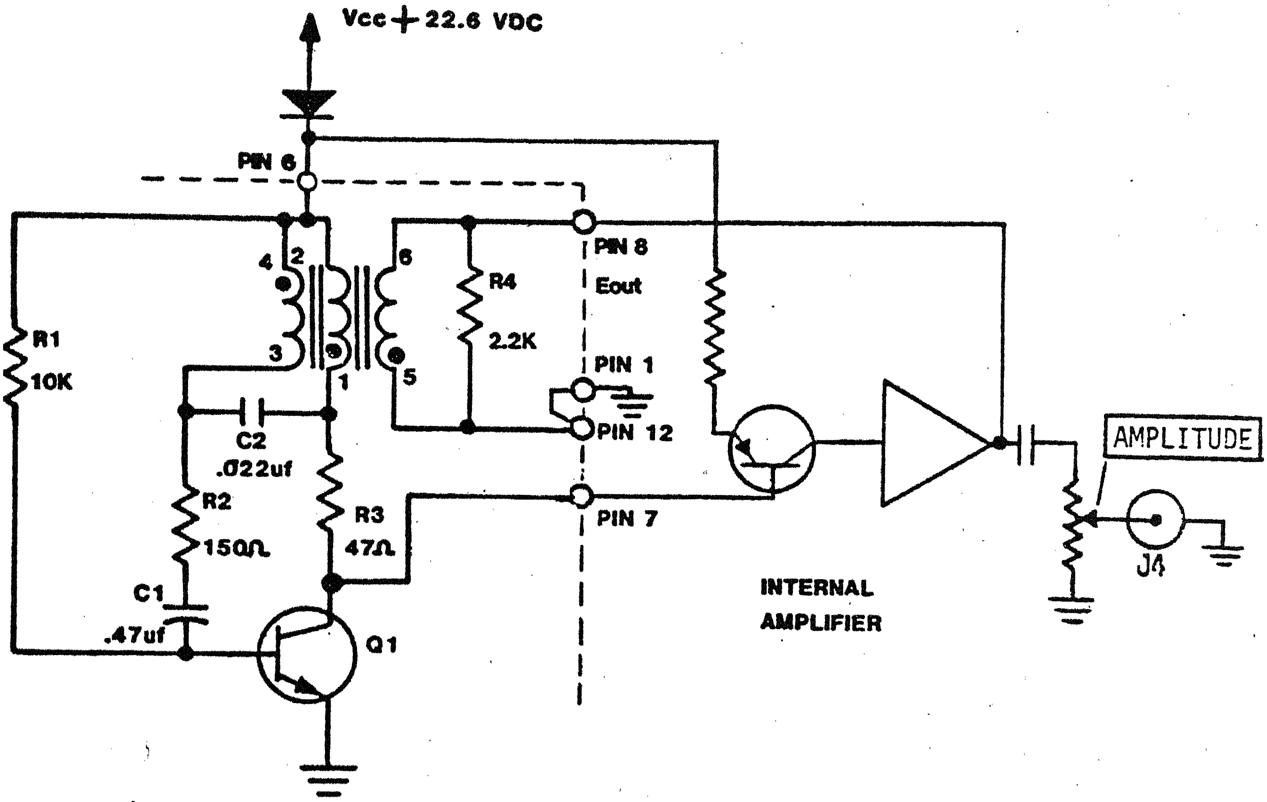
Explain in your own words why the component listed in steps five or six above would cause the symptoms listed in steps one and two of the six step troubleshooting procedure? Write your answer in the space provided on the troubleshooting form.

TAKE YOUR SIX STEP TROUBLESHOOTING SHEET TO YOUR LEARNING CENTER INSTRUCTOR FOR VERIFICATION AND EVALUATION.

VOLTAGE/RESISTANCE CHART FOR BLOCKING OSCILLATORS

The following voltages and resistances were taken from a properly operating Blocking Oscillator with a Simpson 260 multimeter. All voltages and resistances were taken with reference to ground or circuit common. All voltages and resistances will be accurate to within ± 20% tolerance.

Point of Check	Voltage	Resistance
V_{CC}	20.8 VDC	1.7 K ohms
V_B Q1	-1.5 VDC	910 ohms
V_C Q1	17.8 VDC	1.65 K ohms
Pin #1 of T1	19.3 VDC	1.68 K ohms
Pin #3 of T1	20.6 VDC	1.72 K ohms
Terminal #8	0 VDC	480 ohms
Primary winding T1(pin 1 to 2)	0.32VDC	30 ohms
Secondary winding(pin 3 to 4)	0 VDC	35 ohms
Tertiary winding(pin 5 to 6)	0 VDC	1 K ohm



BLOCKING OSCILLATOR

PC 203-6

Revised 1-1-81

ANSWER SHEET FOR
PROGRESS CHECK
LESSON 3

Wien-Bridge Oscillator

QUESTION No.	CORRECT ANSWER	QUESTION No.	CORRECT ANSWER
1.	a.	6.	b.
2.	d.	7.	d.
3.	c.	8.	b.
4.	c.	9.	a.
5.	d.	10.	c.

ANSWER SHEET FOR
PROGRESS CHECK
LESSON 4

Blocking Oscillators

QUESTION No.	CORRECT ANSWER	QUESTION No.	CORRECT ANSWER
1.	d.	6.	d.
2.	a.	7.	d.
3.	c.	8.	d.
4.	b.	9.	d.
5.	a.	10.	a.

ANSWER SHEET
FOR
JOB PROGRAM
LESSON 4

Blocking Oscillators

8a. 746 Hz.
 b. 0.28 msec.
 c. 1.05 msec.

12a. 1.34 msec.
 b. Yes

15a. .748 kHz or 748 Hz.
 b. Yes

20a. Decreased
 b. Decreased

NOTES